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Alan Turing: The Man Behind the Machine

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Mathematics

October 6, 2016

Outline

Biographical and Popular Culture Items

- Biographies (Hodges 1983, . . . , 2012, Leavitt 2006)
- *Breaking the Code*, Play, 1986 and BBC TV, 1996 (Derek Jacobi)
- *Codebreaker*, TV Movie/Documentary (2011, Ed Stoppard)
- *The Imitation Game*, Film (2014, Benedict Cumberbatch)
- Music: electronic, choral, operatic, a work by Pet Shop Boys (*A Man from the Future*)

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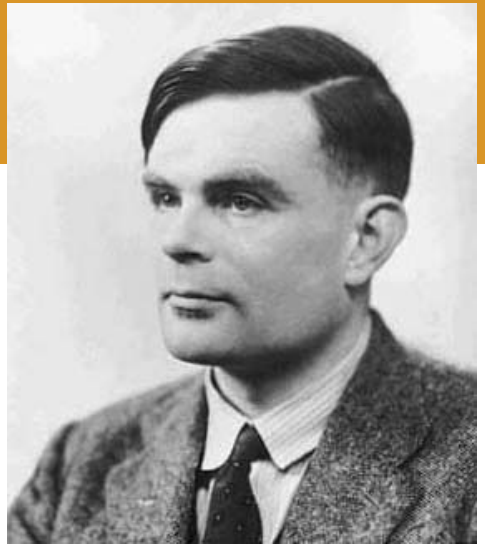
- Music: electronic, choral, operatic, a work by Pet Shop Boys (*A Man from the Future*)
- Why all of this attention?

Alan Mathison Turing (1912–1954)



- Born in London in 1912, parents often in India
- 1926, Attended Sherborne, Christopher Morcom (d. 1930)
- 1931, Went to King's College, Cambridge (Keynes, Forster, etc.)
- 1935, Fellow at King's, Central Limit Theorem (Lindeberg, 1922)
- 1936–38, Princeton (Disney's *Snow White*)
- Worked for British government at Bletchley Park, WWII, and in London afterwards
- 1948, Reader at Manchester University
- Died in 1954 from cyanide poisoning, ruled a suicide

The *Entscheidungsproblem* (1928): Is there an algorithm to decide if a theorem can be proved from the axioms of the system?

Hilbert's 1930 radio speech: "Wir müssen wissen; wir werden wissen."

On Computable Numbers (1936)

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By A. M. TURING.

[Received 28 May, 1936.—Read 12 November, 1936.]

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T defines "computability" algorithmically/mechanically

On Computable Numbers (1936)

We may compare a man in the process of computing a real number to a machine which is only capable of a finite number of conditions $q_1, q_2, \ldots, q_R$ which will be called "m-configurations". The machine is supplied with a "tape" (the analogue of paper) running through it, and divided into sections (called "squares") each capable of bearing a "symbol". At any moment there is just one square, say the r-th, bearing the symbol $\mathfrak{S}(r)$ which is "in the machine". We may call this square the "scanned square". The symbol on the scanned square may be called the "scanned symbol". The "scanned symbol" is the only one of which the machine is, so to speak, "directly aware". However, by altering its m-configu-

Turing Machine (TM)

T describes what would be called the "Turing Machine": a machine with a set of configurations; a tape divided into squares; a scanner to read the tape

- erase symbol there
- write new symbol there (0 or 1, or perhaps 0-9)
- move right or left one square
- change to a new configuration

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- T shows that the Entscheidungsproblem can be reduced to a similar "decision problem" about a TM, one with a negative result.

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- Therefore Turing proves that Hilbert's Entscheidungsproblem is impossible.
- Solved independently in 1936 by Alonzo Church (1903–1995).

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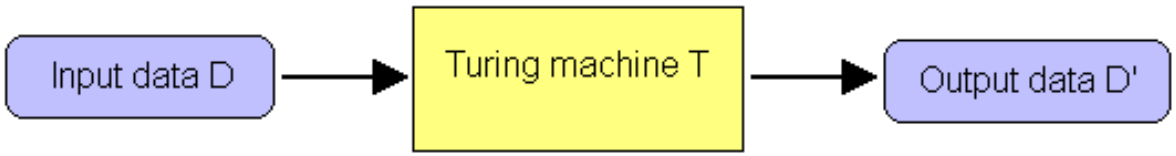

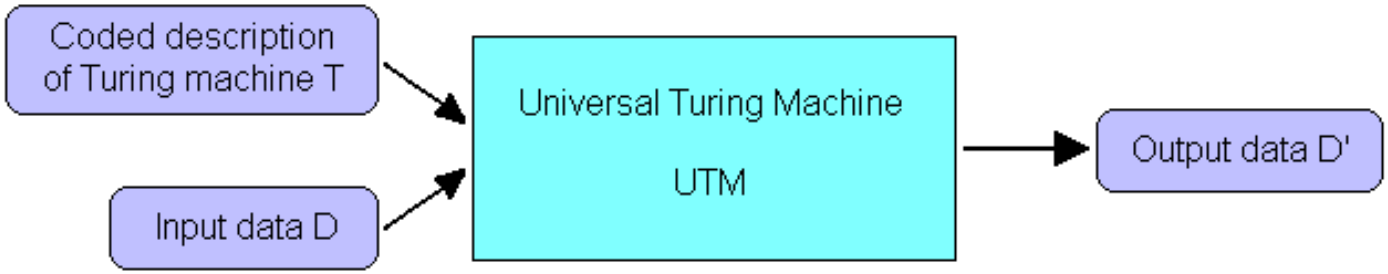

http://science.slc.edu/ jmarshall/courses/2002/fall/cs30/Lectures/week08/Computation.html

Theory & Practice

T was always a tinkerer. He built a few early computers, and wanted to write a chess program.

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The Point: T did more than just come up with the mathematics and logic. He also did the engineering.

WWII work

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The Point: It was a team effort & T was a leader

After WWII

VOL. LIX. No. 236.] [October, 1950

MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to

Computing Machinery and Intelligence, Mind **LIX** (236) (T, 1950)

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- Passed test (Veselov, Demchenko, & Ulasen, 2014)

Turing test, xkcd.com

The Imitation Game

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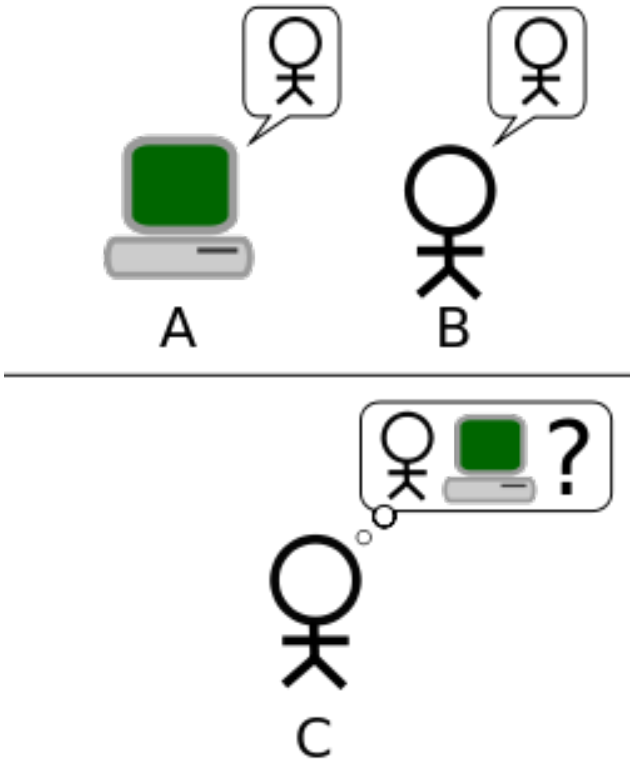
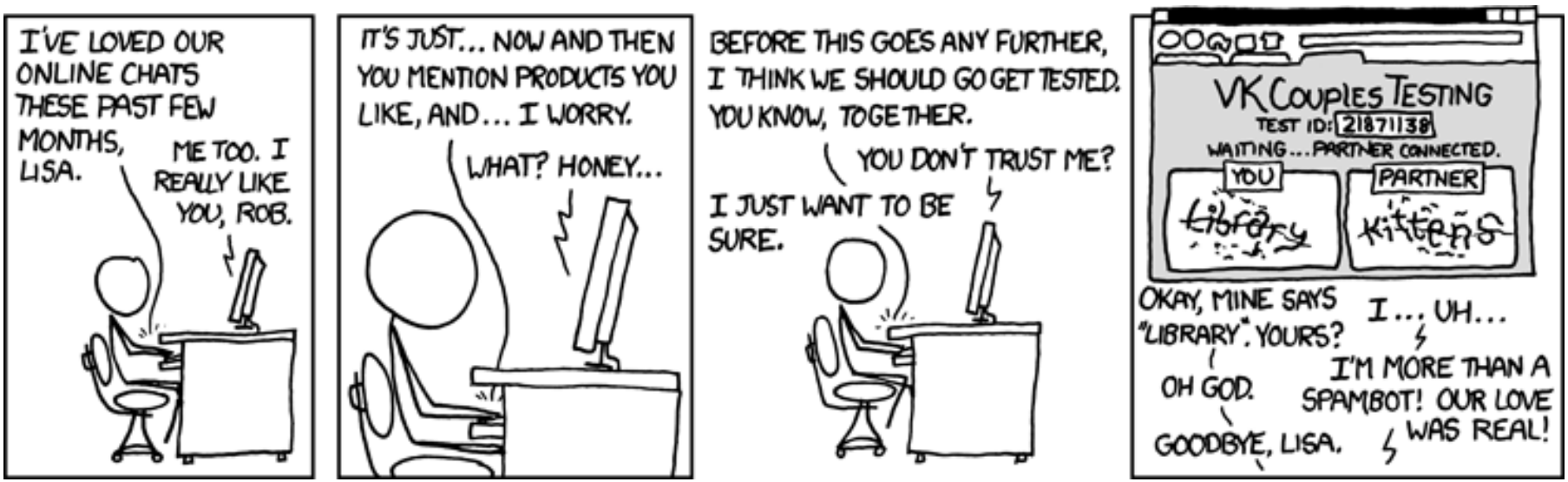


What is lost or gained by removing gender from the test?

Suspicion, xkcd.com



Morphogenesis

- T. (1952). "The Chemical Basis of Morphogenesis". *Philosophical Transactions of the Royal Society of London* **237** (641): 37–72.
- T uses differential equations to model cell conditions leading to pattern formation

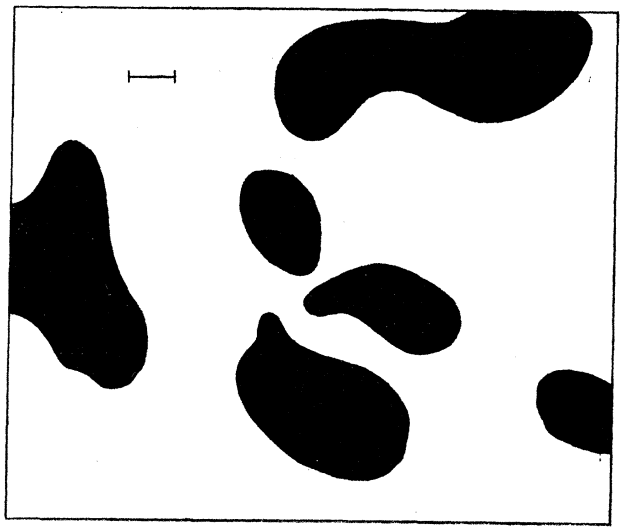


FIGURE 2. An example of a 'dappled' pattern as resulting from a type (*a*) morphogen system. A marker of unit length is shown. See text, §9, 11.

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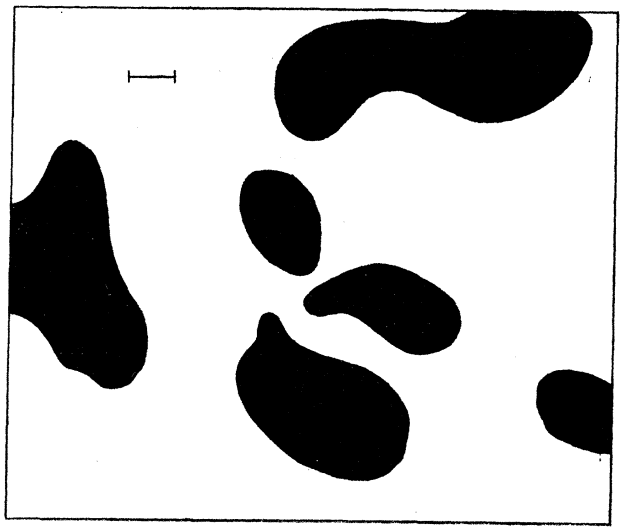

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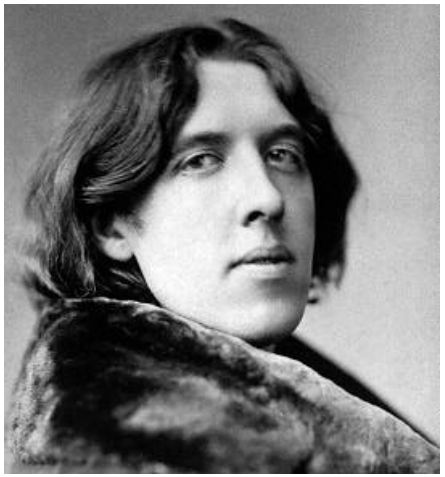
- Biochemical machines

Homosexuality before 1952

- Gross Indecency, 1885
- Oscar Wilde, 1895
- Kinsey report, 1948
- Red Scare/Lavender Scare (McCarthyism, c.1950)
- Guy Burgess (of the Cambridge Five), 1951, 1956



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- T chose probation (which ended in April 1953)
- *The Chemical Basis of Morphogenesis* appears

After 1952

- Watson and Crick, 1953
- Turing's death, June 1954 (accident vs. suicide)
- Decline of McCarthy, 1954
- Wolfenden report, 1957, 1967

Legacy

- Computability (Universal Turing Machine)
- Code-breaking effort (OBE by King George VI, 1945)
- Computer science & AI (Turing test)
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- Did not name his computer Christopher
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- What role did his homosexuality play in the development of his ideas?

Intersections

- Double life, secret life
- Speaking in code
- What is being imitated in the imitation game?
- Is homosexuality part of our programming?

Turing Test and Gender

Some questions:

- Why do you think the description of the "Turing test" has morphed from a gender-based parlor game to a human vs. computer paradigm?
- What is gained or lost by this approach?

Thank you!